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Energy governance in the context of energy service security: A qualitative assessment of the electricity system in Bangladesh

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HIGHLIGHTS

- Conceptual framework of energy governance with respect to energy service security.
- Inductive thematic analysis yields 13 energy governance indicators in 4 dimensions.
- Qualitative assessment of Bangladesh's electricity system.
- Policymakers face several challenges to achieve energy service security.
- Current policies are in conflict with climate change mitigation targets.

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ABSTRACT

Soaring energy demand in developing Asian countries presents a challenge for existing centralized systems and monopolistic electric utilities since these often fail to reliably provide energy service security. Inclusive energy governance could serve as a hedging mechanism against several inherent problems such as supply disruptions and corruption practices, and thus improve energy service security. This study therefore (i) proposes a conceptual framework for energy governance in developing countries and (ii) applies this framework to qualitatively assess the energy service security perspectives of the electricity system in Bangladesh via an interpretive research approach. Relevant governance indicators were first identified in an inductive thematic analysis of systematically selected literature. Bangladesh's electricity system was then subsequently qualitatively analyzed on the basis of secondary data and official reports. The findings indicate the presence of weak institutions in the electricity sector and a lack of market competition, and the need for consistent policy implementation, proper pricing and information disclosure mechanisms. In addition, other challenges such as endemic corruption and bureaucratic complexities, underdeveloped grids and insufficient resource logistics also need to be addressed. While international interventions and national policies favor a heavy take-up of fossil fuels in order to achieve energy security and energy equity, environmental sustainability is largely ignored. The study concludes that the integration of energy governance and energy security perspectives is crucial to understanding and addressing the challenges of a just energy transition in the face of the standard energy trilemma in developing countries.

1. Introduction

1.1. Energy governance in the electricity system

Resource and energy-intense economic growth in developing Asia represents a significant challenge when attempting to achieve a just energy transition [1–3], especially when considering the energy trilemma, i.e. the competing goals of energy security, energy equity, and environmental sustainability [1,4]. The emerging revolution in the Asian energy paradigm involves a growing and latent energy demand on the one hand, and path-dependent fossil fuel regimes on the other hand [5]. At the same time, several countries suffer from intense climate change vulnerabilities [5].

While such complex challenges call for multilateral cooperation in energy governance, i.e. cooperation on local, regional and global levels, the current institutional settings seem inappropriate [1,6–9]. The quality of governance is suffering from fragmented institutional arrangements, inconsistent policy processes, and unclear levels of authority across diverse energy-related institutions and actors [8–12]. Resource-nationalist strategies prevail and require energy diplomacy in

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securing energy resources [13–15].

The environmental and social acceptability of energy generation heavily depends on the regulating capacity of local institutions and transparent policy frameworks [16]. However, political imperatives, incumbent lobbying, and intellectual property rights often induce complications which need to be addressed [8]. An effective governance regime is thus instrumental in the de-carbonization of energy systems [17].

The electricity system is of particular interest due to its significant CO_2 emissions, as well as its vulnerability to short-term disruptions [18–19]. Monopolistic electric utilities in developing Asia often fail to properly address reliable electricity provision [7,20–21]. The regulatory governance of the electricity sector in such countries is affected by weak institutional capacity, political instability, poor technical and financial performance, state budgetary constraints, and donor-driven lending mechanisms [20,22–23]. Energy governance could serve as a hedging mechanism against supply disruptions, corruption, (e.g., in infrastructure construction and operation of electric utilities), and against non-technical losses (e.g., electricity theft or illegal connections) [24]. With improved energy governance it is supposedly also easier to enhance the security of energy services as well as to manage political pressure, tax and subsidy burdens, or the mitigation of cross-border free-riding on climate change [9,25].

The various perspectives of energy governance do rarely receive distinct research attention [12]. Energy governance is commonly treated as a sub-indicator in energy security studies. Only a few studies [16,26–28] have used quantitative indicators for governance, including quality of governance, trade and connectivity, competition, transparency etc. Sharma and Balachandra [29] studied both quantitative and qualitative indicators in the context of policy and institutions representing energy sector governance. Ang et al. [25] highlighted government policies, infrastructure planning, energy taxes and subsidies, information dissemination and energy diplomacy as the key perspectives of governance. Apart from that, a number of studies have included qualitative or quantitative indicators related to policy or politics, but not from a governance perspective. For example, one framework for evaluating energy security [30] includes six worldwide governance indicators (WGIs) such as political stability, regulatory quality, rule of law and control of corruption, but only as sub-indicators to measure socio-political strength. Other studies [31–33] also used WGIs to assess electricity provision. In contrast, [34] introduced the sovereign credit rating as a proxy indicator for political-economic strength in order to measure energy security. Apart from that, only relatively few studies [16,35–37] have incorporated qualitative indicators such as institutional politics, international aspects, geopolitical conflict, and market liquidity to assess energy security (for details, see Supplement A).

A critical review of the existing literature reveals that the selection of energy governance indicators is rather generic; a systematic selection of context-specific energy governance indicators is rarely attempted [1]. For example, WGIs include a range of several hundred sub-indicators to assess overall governance perception. However, a workable set of indicators for international governance domains is still lacking for context-specific energy research. An attempt to quantify qualitative indicators using proxy attributes often undermines the robustness of energy security studies. For example, the underlying subjective foci such as trade willingness, level of openness and political conflicts between states are often excluded in assessing political stability or political affectability [38–40]. Moreover, political aspects, such as transnational cooperation, national and international market structure or regime effectiveness, have largely been overlooked in energy security studies [16,38,41].

In terms of assessment, indicator-based approaches are predominant; a set of disaggregated or aggregated energy indicators generally assess system performance based on a number of simplified assumptions and complex manipulations [14,42]. Due to their very nature, quantitative approaches often present a 'partial and simplified view' [43] and disguise dynamic relationships between the system elements in question [39,44–45]. Statistical analyses of WGIs fail to incorporate complex interactions between governments, institutions and electrification due to the necessarily simplified additive assumptions [31]. Data availability is another important pre-requisite that often cannot be met in the developing countries [14,29,46–47]. In fact, energy governance in general, and how the quality of governance influences energy service security in particular, is rather difficult to quantify [25,34,48–49]. Sovacool [47] opined that "quantification does not mean that determining what is measurable captures what is always meaningful".

The inclusion of qualitative indicators definitely facilitates a deeper understanding of the subject matter under study [50]. Qualitative approaches thus tend to support quantitative measures [25]. With regards to energy governance and energy security, only a few studies [1,51–52] have aimed for qualitative empirical analyses.

The aim of this paper is thus (1) to develop a conceptual framework for energy governance while taking account of different energy service security perspectives and (2) to apply this framework to a qualitative analysis of Bangladesh's electricity system. We applied an inductive thematic analysis to systematically derive those relevant energy governance indicators that influence energy service security in developing countries. Choosing Bangladesh as a case study contributes to an improved understanding of emerging economies in Asia, as has been proposed in recent energy research agendas [53]. The relevant contextual factors for Bangladesh and its fast-growing economy [50] are the rising electricity demand, limited indigenous fuel reserves, a patchy and state-controlled energy infrastructure, technological destitution, and climate change vulnerabilities. This study thus aims to be of benefit not only to academics, but also to national and international policymakers in understanding complex trade-offs between energy governance and energy service security based on a set of interpretive qualitative toolkits.

The remainder of the paper is structured as follows: In Section 1.2 the authors' perspective on energy governance and energy security is defined. Section 2 describes the chosen research approach. In Section 3, we present a qualitative conceptual framework for analyzing energy governance, which is then applied in Section 4. Section 5 concludes the paper by summarizing the main findings and reflecting on the relevance of integrating energy governance and energy security perspectives.

1.2. Energy governance and energy security

The concept of energy governance is highly context-dependent; it usually includes attributes related to politics and policy [54], such as international interactions, interactive and coordinated arrangements, institutionalized rules, and, last but not least, a complex and diverse array of actor groups [1,24,55]. Thus, we understand energy governance as a process of coordination in which institutional properties (system of rules, policies) and interdependent (public-private) actor constellations interact to decide how to provide energy services.

The concept of energy security is still ambiguous and slippery due to multi-faceted contextual interpretations [1,14,30,56–57]. Several studies defined energy security using multidimensional perspectives [44,46,58], such as the "four As of energy security" – availability, affordability, accessibility and acceptability- or, "four key dimensions" – availability, affordability, reliability and environmental sustainability [14,16]. Alternatively, Cherp and Jewell [18,59] prescribed three perspectives (sovereignty, robustness and resilience) to assess the vulnerability of 'vital energy systems' and Gracceva and Zeniewski [43] proposed five key systemic properties of energy security, namely stability, flexibility, adequacy, resilience and robustness. We take a slightly different approach to defining energy service security, as we aim for an integration of energy governance phenomena. By energy service security, we thus refer to the security of access to reliable, affordable and modern energy services (electricity), security of energy

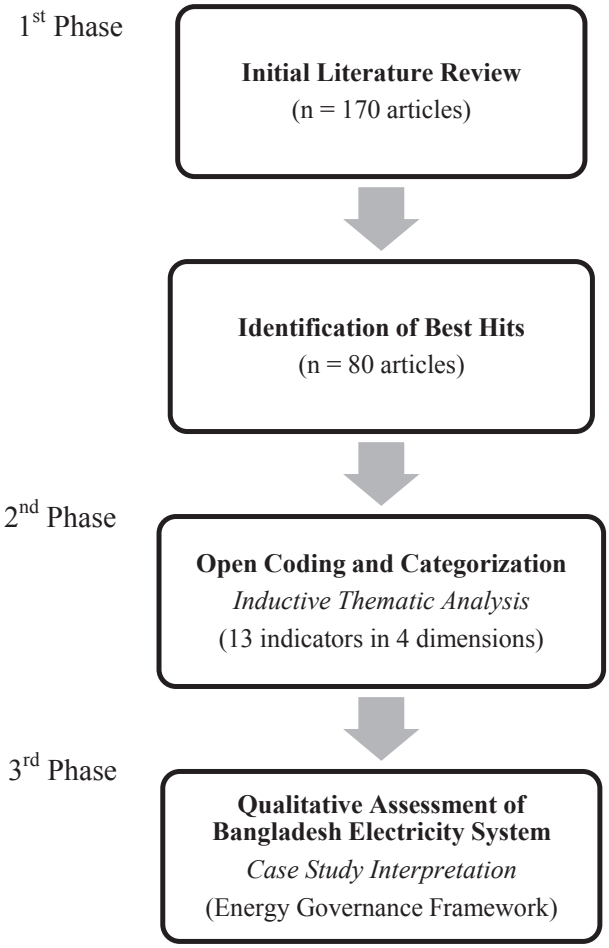

Fig. 1. Methodological framework of the study.

resource supply and development cooperation, and reliability of political process. Related issues associated with electricity systems, such as adequate electricity supply, equitable electricity pricing, cross-border energy relations, energy trading, technology transfers as well as political regulations and endowments, have also received pronounced attention from the academic and policy community [9,30,34,56,60–61].

2. Methods

The present study applied a qualitative method grounded in the interpretive research tradition. The interpretive tradition deals with 'sense-making' approaches of social inquiries in relation to existing theoretical and empirical literature [62]. The study was implemented in three phases as outlined in Fig. 1.

The first phase involved a systematic review process [63–64] to identify indicators relevant to energy governance and related to energy security. Generalized search terms were used in online databases (e.g., ScienceDirect) and professional networks (e.g., ADB, World Bank). The search terms (detailed in Supplement A) returned a substantial number of peer-reviewed articles and book chapters published during the last 10 years. After a thorough review of 170 articles, a total of 80 articles contributed to the conceptualizing of how energy governance indicators influence energy service security.

The second phase involved an inductive thematic analysis to identify the relevant energy governance components. This method, as proposed in [65–66] and applied in [51,67], aims to identify and analyze the patterns of meaning based on an inductive process. The themes are abstract motifs that contain both explicit (manifest) and implicit (latent) contents [66]. Themes describe meaningful and coherent concepts on an interpretative level integrating the underlying elements within a dataset [65,68]. This inductive analysis yielded 13 interpretative indicators (sub-themes) which were grouped into four broader dimensions (themes). Supplement A provides details of the theme development framework.

In a third phase, we applied this framework to qualitatively assess the electricity system in Bangladesh. We adopted an interpretive perspective of the qualitative case study, as proposed by Stake cited in [69], to intensively investigate various aspects of energy governance in relation to energy service security. This qualitative assessment represents contextual descriptions and causative interpretations of the governance indicators which influence electricity security provision in Bangladesh. Secondary sources, including government policies, reports and statistics, as well as scientific articles, all served as a basis for assessment.

It is important to recognize that any (qualitative) study, including this one, is subject to several limitations. The first limitation of the study is related to the development of the framework. The latter clearly requires subjective judgments in terms of the coding of themes, indicators and dimensions. Ultimately, the researchers' judgments are the reference points for structuring themes in such an inductive approach [70], especially when the existing research is either limited or fragmented [71–72].

Another limitation stems from the fact that indicators of energy governance are not exhaustive and not necessarily mutually exclusive [73–74]. The selected indicators were chosen on the basis of well-established and empirically demonstrable concepts associated with energy governance in the context of developing countries. However, the chosen categorization is not the only one possible. Note that the selection of dimensions and indicators is rather context-dependent and influenced by the research objectives in question [39,57].

Beyond framework development, information on energy governance and energy security topics is often scarce in developing countries [47,75]; data is often lacking, or when available, is not accessible for researchers. This seems to be particularly true for Bangladesh. Some of the assessments can therefore only be made based on incomplete data.

Keeping these limitations in mind, we argue that the chosen systematic selection and qualitative assessment of relevant indicators within an interpretive perspective is still of value. This thematic framework contributes to developing a knowledge base for energy governance in the context of energy service security as a distinctive research phenomenon, and allows for empirical, qualitative assessments of energy governance, especially for those subjective settings which are difficult to translate into numbers.

3. Conceptual framework

A framework, that describes the multidimensional perspectives of a particular research context, may meaningfully extend the conceptual underpinnings of an existing, incomplete knowledge base [43]. This section describes the conceptual lens on energy governance, based on the methodology outlined above. The inductive thematic analysis of the literature, together with the synthesis of the identified themes yielded four dimensions and 13 qualitative indicators. These are listed in Fig. 2. Qualitative indicators provide valuable information when quantitative representations fall short [76], as is the case with energy governance and energy service security [48].

The proposed framework offers a qualitative guideline to understanding how energy governance indicators influence the predominant contexts of energy service security: security of access to reliable, affordable and modern energy services, security of energy resource supply and development cooperation, and reliability of political processes. A qualitative investigation of such complex interactions provides a deeper insight into those problematic or challenging aspects of energy governance that need policy attention in order to improve energy service security, especially when analyzing a developing country

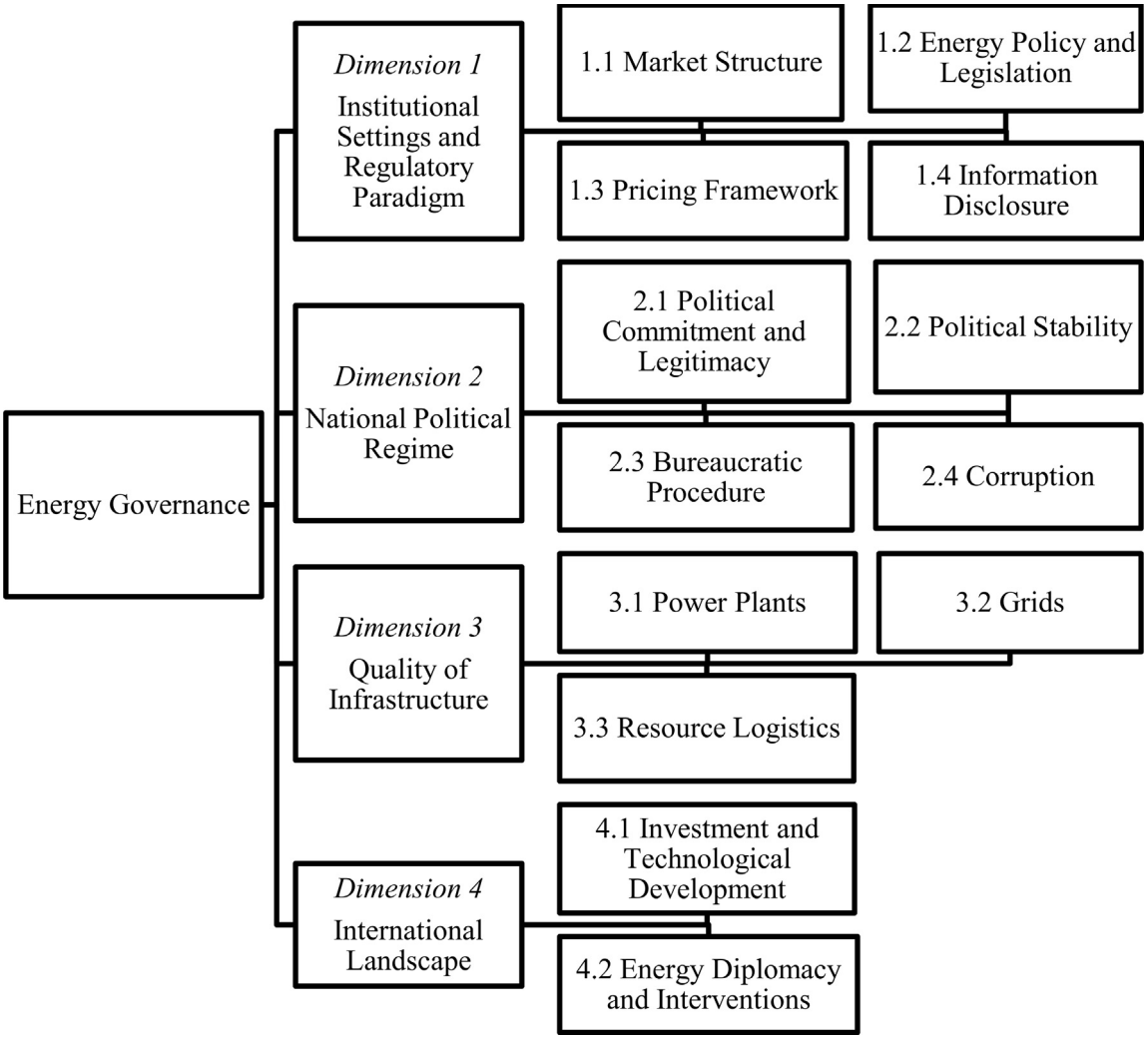

Fig. 2. Conceptual framework of energy governance in the context of energy service security.

with limited resource endowment. Apart from that, qualitative policy analyses are important complements to classical quantitative approaches [61].

3.1. Institutional settings and regulatory paradigm

The first dimension identified, *institutional settings and regulatory paradigm*, refers to the regulative perspectives of institutional theory in which formal organizations create and enforce rules of the game (laws, regulations and outlines) [77] for the existing socio-technical systems, i.e. the electricity system. Formal rules and established practices influence actors' (regulators, policy-makers, producers, consumers etc.) behavior, while downplaying the role of informal institutions (e.g., social & cultural norms and collective expectations) [78]. This dimension is represented by four indicators.

A state-owned and vertically integrated electricity system provides nationwide electricity provision through a single utility setting (i.e. generation, transmission and distribution). The market arrangements depend on the degree of competition and are categorized in terms of four models, namely monopoly, purchasing agency, wholesale competition and retail competition [79–80]. The liberalization process takes place through electricity reform in order to ensure reliable and affordable electricity provision [81]. Electricity reform is a structural adjustment or rearrangement of the existing market and institutions [82]. It involves a 'standard toolbox' consisting of nine sequential milestones/elements: corporatization and commercialization, electricity laws, a regulatory authority, independent power producers, functional disintegration, privatization of distribution, and generation, and wholesale and retail competition [20,83]. Hence, the competitive electricity markets increase security of supply and lower electricity tariffs by introducing market competition, system efficiency, and increased power generation by the private sector. However, the potential reform benefits are subject to the respective impact of a robust socio-political environment and the credibility of the institutional endowments of the implementing country [21,80,83]. [Indicator 1.1: *Market Structure*]

Energy policy deals with multifaceted national energy problems (e.g., insecure energy supply) and in particular, policy tradeoffs between different energy sources in the electricity generation mix with regards to climate change mitigation [84–85]. Energy policy strategies set content-based policy objectives (e.g., 100% electrification rate, emission reduction target) in which climate policies are often co-opted as benefit mechanisms for ensuring energy security [86–87]. Necessary principal action plans (e.g., energy master plans) and concrete policy instruments are formulated to achieve stated objectives [86]. In addition, energy legislation establishes institutionalized rules and regulatory mandates for the national electricity system [88]. However, the effective implementation of favorable policy instruments (e.g., feed-in-tariffs) as well as energy and climate policy is influenced by the domestic political settings [85,89]. [Indicator 1.2: *Energy Policy and Legislation*]

Affordable electricity bills with respect to end user income level are

key to the distributive aspects of reliable energy service [90]. However, affordability entails different interpretations based on the contexts in question, for example, 'security for whom (referent actor)' [59] or 'systemic security' [43]. The electricity tariff structure determines a low energy price for consumers through 'cross-subsidization' across different consumer segments [33]. It also reflects the profitability of energy investment for the generation companies through allowing for the setting of cost-based electricity selling prices [46]. [Indicator 1.3: *Pricing Framework*]

In the absence of regulatory pressure, the energy sector, by its very nature, is resistant to informational mobility. Incomplete or asymmetric energy information (e.g., reserves & production of fossil fuels) and policy uncertainties (e.g., climate change mitigation) lead to price volatility in the trading market [91–92]. Apart from that, energy-related information exchange between users and holders of information on a 'voluntary and self-regulatory basis' is crucial to establishing fair and transparent decision-making processes in delivering reliable energy services [91]. This democratic practice calls for deliberative citizen participation that establishes collaborative governance. As a result, context-specific information, including technological complexity, local resources and user preferences, can be communicated to the implementing authorities [17,93]. [Indicator 1.4: *Information Disclosure*]

3.2. National political regime

The second dimension identified in the framework, *national political regime* relates to the political character (ideology, circumstances, practice, culture) of governments and associated bureaucracies [94] which influence the contexts of energy security policies. This dimension includes four indicators as well.

Political contexts are inherent in the national policy formulation and implementation process [94]. Hence, reliable energy service provision (e.g., universal electrification) is predominantly influenced by political decisions [31–32]. To alleviate energy poverty, the government intervenes in sectoral electricity consumption through different mechanisms, including subsidies and regulatory structures [33,95]. Rural electrification is often considered as a prime agenda in electoral politics. Politicians place emphasis on extending national grids to the peri-urban and remote areas, while less attention is given to the quality of existing infrastructure in the urban areas [96]. Apart from that, a concrete political vision, and strong political discourse and support are used to initiate a sustainable transition process in the electricity system and to address related socio-environmental externalities (e.g., human security, climate change mitigation) [61,89,97–98]. [Indicator 2.1: *Political Commitment and Legitimacy*]

The stability of energy service security policies are inherently linked to electoral cycles often resulting in some form of periodicity in the national government position [89]. Frequent changes in political leadership or in the nature of political conflicts or party coalitions may lead to stalled implementation or even termination of existing energy policies [31,97,99–101]. Thus, the overall political systems seem to affect the functional mechanisms of the electricity system. [Indicator 2.2: *Political Stability*]

In a monopolistic electric sector, the delivery of effective utility services requires an inclusive and well-functioning bureaucracy. The administrative structure involves formal procedures with a varying degree of political influence and implementation time lag [102]. However, the higher number of procedures coupled with technical complications raise bureaucratic complexity in different phases of the regulatory decision-making process. Such prolonged deviations and excessive bureaucracy might weaken the functional capacity of the administration and result in an overall system inefficiency, especially in the context of poor institutional settings [31,50,102]. [Indicator 2.3: *Bureaucratic Procedure*]

The level of corruption tends to affect the security of access for quality energy service [103]. In the electric power utility, corruption includes different forms of malpractice at both the consumer and firm level in exchange for informal payments or collusive bribes. Electricity theft (e.g., meter tampering, illegal connections and unpaid bills) is a common phenomenon in the poorly connected areas [104–105]. In addition, commercial firms tend to become involved in bribing utility employees in order to secure reliable electricity connections for their operations [106]. Such practices cause electricity grid overexploitation, leading to system failures and frequent power outages and voltage fluctuations [105–106]. [Indicator 2.4: *Corruption*]

3.3. Quality of infrastructure

The third dimension, *quality of infrastructure,* relates to the availability and adequacy of physical energy infrastructure to ensure uninterrupted electricity access [43,107–108]. A reliable electricity supply chain responds to aggregate electricity demand (capacity adequacy) during peak demand (blackouts and power rationing). It also absorbs unexpected technical disturbances using operational contingency planning [48] and is critical in dealing with non-technical vulnerabilities, for example, political violence, terrorism etc. [31,109].

This systemic quality of a secure supply chain is, however, subject to the core functions of the physical components. Electricity generation infrastructure produces electricity required to match demand using different fuel resources. The latter are transported to power plants by logistical support systems (roads, railways, ports and pipelines). Transmission and distribution infrastructure then facilitates supply of electricity to the users. However, technical (e.g., transmission lines, transformers) and/or non-technical losses (e.g., electricity theft) may cause system failure and consequent supply-demand mismatches. Thus, system hardware (physical infrastructure) is necessary for reliable electricity provision. [Indicator 3.1: *Power Plants*; Indicator 3.2: *Grids*; Indicator 3.3: *Resource Logistics*]

3.4. International landscape

The fourth dimension, *international landscape,* captures transnational energy-related cooperation and cross-border political conflicts [38]. International energy relations foster policy advocacy through political dialogue and negotiation, technical capacity development and knowledge sharing through joint research collaboration, and investment partnership in infrastructure projects [110]. This dimension includes two indicators.

Adequate infrastructure investment is a prerequisite to overcoming the challenges of an underdeveloped electricity system [23,31]. A weak domestic financial system often fails to accommodate large-scale infrastructure financing [111]. Thus, integrated collaboration with international development partners and governing entities is often helpful. The emerging economic powers, as well as other multilateral development banks, facilitate different investment vehicles (e.g., concessional loans, grants) for the energy infrastructure development necessary for electricity supply [110,112]. Also, capacity investment or electricity integration, i.e., regional power trading, is a complementary mechanism to increase electricity access and to diversify generation mix [23]. On the other hand, the development partners provide technical assistance and policy advice when deploying imported technologies, in particular clean energy technology [113–116]. In a technology transfer process, both physical capital equipment and knowledge are exported to the importing countries in order to develop technical capacity [117]. However, effective international collaboration depends on critical factors such as political and technical negotiations and national absorptive capacity [23,118]. [Indicator 4.1: *Investment and Technological Development*]

The political economy of 'energy realism' emphasizes the security of national energy policy in which a country attempts to secure strategic energy resources through market intervention and diplomatic activities [85,119]. Energy diplomacy entails the dynamic interplay between

different actor groups, e.g., state, non-state, or donor agencies, to enhance energy supply and to manage cross border energy trades and relations [55,120]. The governments of both importing countries and exporting countries exercise political influence in order to secure the supply of energy resources and/or to enhance strategic access to overseas reserves. The diplomatic arrangements comprise different forms of international negotiation, including, competitive bidding, government-to-government contracts or preferential treaties. However, powerful foreign governments and their donor organizations often attach strict terms and conditions in the trade agreements or lending policies [9]. This might compel the recipient governments to enact significant regulatory changes in order to protect foreign investors' interests. Any related processes of international arbitration, may thus be claimed as being 'part coercive and part persuasive' [112]. [Indicator 4.2: *Energy Diplomacy and Interventions*]

4. Findings and discussion

This section analyses the electricity system of Bangladesh according to the framework described in Section 3. The dimension-wise illustrations of the case study are presented in the following subsections.

4.1. Institutional settings and regulatory paradigm

4.1.1. Market structure

In the early 1990s, the electricity sector in Bangladesh had to confront several critical issues, including inadequate supply and generation capacity, endemic power outages, financial defaults, and chronic investment shortages [121]. As a result, public electric utilities[1] underwent institutional reforms, as proposed by international policy advocates and donor agencies. The implementation of several reforms followed a 'phase-wise learning by doing' approach in the period 1996–2008 [121–122]. Reforms included the enactment of new distribution and generation companies through a functional unbundling of existing utilities. A natural monopoly for transmission utility was then set up and a regulatory commission established as an independent regulator. Furthermore, policies were aligned and regulations formulated to attract private investments in the form of independent power producers (IPPs), and to expand the base load power generation [121,123–124].

Almost every aspect of electricity provision improved notably during the different reform periods (Table 1). For example, an over threefold expansion in grid-connected generation capacity and a 79% increase in electrification rate was achieved during 2001–2017. After the rural electrification board (REB) led a reform to establish rural electricity cooperatives ('*Palli Bidyut Samity', PBS*) and decided to provide performance-based funding [125–126], the coverage of reliable electricity in rural areas went up from 19% in 2000 to 67% in 2016. As the strict performance targets are often hard to achieve in remote areas [125], the REB also organized the installation of 15,250 (825 kWp)[2] solar home systems (SHSs) to cover basic electricity needs.

IPPs are backed by a power purchase agreement with the government, including a transparent bidding process and a contractual framework for building, owning and operating plants [121]. Private power generation has contributed significantly to the national installed capacity since the initial reform periods, increasing from 26% in 2008 to 40% in 2016. Power supply shortages are counteracted by rental power agreements, usually liquid-fuel based [20,121,127]. The respective installed capacity increased by more than 2GW[3] between 2012 and 2016.

Table 1
Reform-led performance statistics of Bangladesh's electricity sector.
Source: Author's compilation from various sources [121,127,141,160].

Reform Periods	Total Installed capacity (MW)	Sector-wise generation capacity (MW)		Electrification ratio (Total/ off-grid)	Generation per capita (kWh)
		Public (BPDB and others)	Private (IPP, rental power)		
Pre-reform period					
1994	2608	–	–	10% (N/A)[1]	84
Initial reform period					
2001	4005	3320	685	17% (N/A)	123
2008	5307	3919	1388	44% (N/A)	174
Interim reform period					
2014	9821	5481	3840	68% (8%)	348
2016	12,365	6569	5002	76% (10–13%)[2]	371
2017	13,555	7833	5122	80% (–)[3]	433

[1] Not applicable since no electricity generation from off-grid renewable sources.
[2] Estimation based on [127].
[3] Exact data not available.

However, these IPP arrangements normally fail to induce market competition as the power purchasers are determined by the authorities in the primary stage of the bidding process [128]. While private investment recently fell short [123], public power generation companies continue to dominate the market (> 50% generation share in 2017). This seems to be a common reform failure in developing economies [83].

To sum up, the status of institutional settings and the regulatory paradigm, Bangladesh is currently in the middle of a transition towards opening up competition in the electricity market. The electricity market is gradually growing, but still the presently installed capacity of ~16GW[4] is insufficient to cover the growing demand emerging from a population of 163 million. It is argued that a small-scale electricity system with private sector generation and functional unbundling tends to perform well under the single buyer model [20]. However, the prospects of neoliberal reform prescriptions are still being debated, especially in developing Asia [83,123,129] where weak governance and poor institutional endowments remain pivotal issues. In terms of institutional quality, Bangladesh is considered the worst performer in South Asia [130] and also consistently recorded a below average score with respect to institutional factors in the ND-GAIN matrix.[5]

4.1.2. Energy policy and legislation

Low per capita consumption (308 kWh in 2017) in grid electricity and no electricity access for one fourth of the population remain challenging energy problems for Bangladesh. The national energy goal aims to achieve '100% reliable and affordable electrification' by 2021 through diversifying energy sources and extending the currently installed capacity of 16GW to around 40–60GW by 2030–2040 [127,131]. The current generation mix is dominated by gas (~67%), with insignificant contributions from renewable sources including hydro (< 3%) (Fig. 3a). In the 2016 power system master plan, imported coal and gas, with a share of 70%, are considered as leading fuels in the generation mix of 2041 (Fig. 3b). The depleting local gas

[1] e.g., Bangladesh power development board (BPDB), Dhaka Electric Supply Authority (DESA) and Rural Electrification Board (REB).
[2] Electricity generation in 2017, Bangladesh Rural Electricity Board (BREB), see http://www.reb.gov.bd/ (accessed 17 December 2017).
[3] Information on the generation capacity of rental power plants was collected from Bangladesh Power Development Board (BPDB) annual reports, see http://www.bpdb.gov.bd/bpdb/ (accessed 17 November 2017).
[4] The installation capacity is based on September 2017; see http://www.sreda.gov.bd/index.php/site/re_present_status (accessed 17 December 2017).
[5] The Notre Dame Global Adaptation Initiative (ND-GAIN); for details, see https://gain.nd.edu/our-work/country-index/ (accessed 17 November 2017).

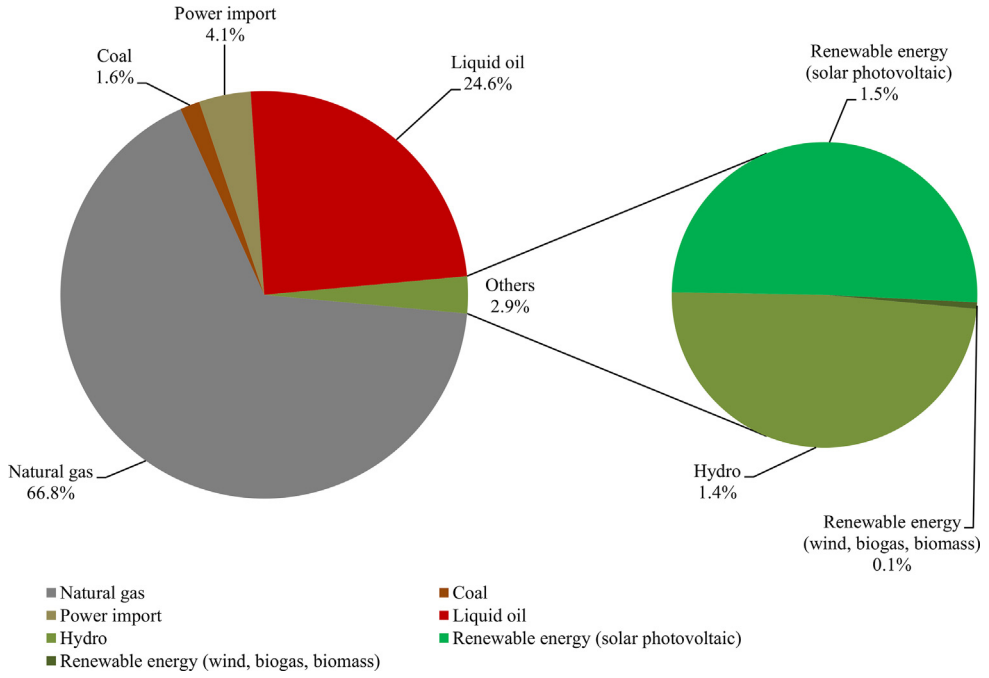

Fig. 3a. Present electricity generation mix of Bangladesh in 2017.
Source: Authors' compilation from the websites of SREDA and BPDB.
Note: The total installed capacity is 16GW as of September 2017, including off-grid and captive generation.

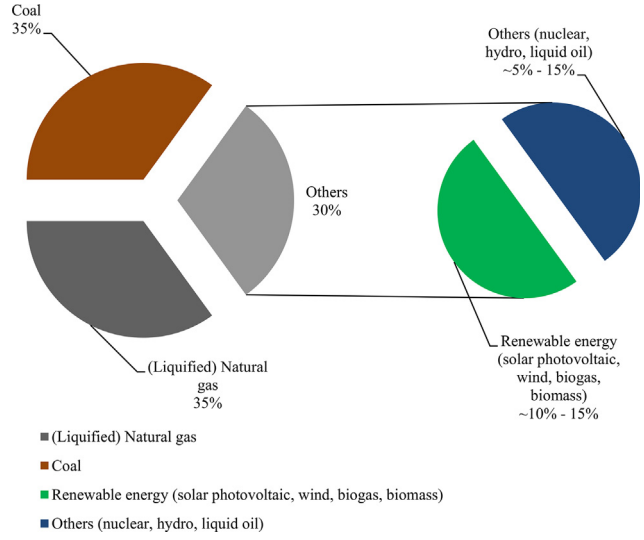

Fig. 3b. Proposed electricity generation mix of Bangladesh in 2041.
Source: Authors' compilation from [127,131].
Note: The targeted installed capacity in 2041 is 60GW.

reserves are to be replaced by imported coal to a larger extent in the upcoming generation mix [127]. In terms of the interim generation target for 2021 (24GW) a number of coal (~8GW), local gas (~5GW) and solar park (~1GW) projects are already in a planning or implementation stage [131]. Even though wind mapping assessments in proposed sites have not been completed yet [131], wind targets are ambitious (~1.3GW) [127]. Government equity assurance is one of the main supportive instruments for large-scale coal power implementation. In addition, feed-in-tariff regulations, as drafted in 2016, have been proposed for small-scale solar rooftop photovoltaic units (< 5 MW) [132].

Renewables mainly play a role in counteracting energy poverty: The diffusion of solar home systems (SHSs) in off-grid areas is supported with installation subsidies [127,133]. Since 2003, IDCOL[6], along with its distribution network of 56 partner organizations, has installed 4.12 million sets with a cumulative capacity of over 200 MW, and currently, this program provides basic-level electricity to 18 million people. However, the growth of SHS installations is expected to decline after 2020 as a result of the national grid capacity expansion [127].

Bangladesh has also set its target for renewables to 10% of generation capacity in 2020 and intends to keep it at this relative level in the following decades [127]. In addition, Bangladesh has submitted commitments to reduce carbon emissions from the power sector, including a 5% unconditional and an 18% conditional reduction by 2030, based on 2011 levels [134]. Solar and wind park installations of 1.4GW will contribute to this mitigation strategy. However, it currently is not clear how the massive extension of fossil fuels can be reconciled with climate change mitigation targets. The renewables development target for 2015 (5%, or 650 MW) was not achieved, and the existing installed capacity (472 MW in 2017) is still lagging behind this target. The policy documents are also inconsistent on renewable installation targets; e.g., 5.6GW from renewables is stated as a probable target in [127], while the overall estimated domestic renewable potential is stated to be only 3.6–4.0GW in [127,132].

Supportive legislation and related policies are being formulated in order to ensure universal electrification [131]. However, lack of coordination, drifting policies, inadequate incentive mechanisms and laggardly execution [127,135–136] remain critical issues in achieving electricity access for all. Apart from that, Bangladesh possesses low bargaining power in the current climate negotiations, making it relatively difficult for it to demand strict reduction targets from strong emitters and/or substantial financial assistance for adaptation support [137].

4.1.3. Pricing framework

The pricing mechanism includes different tariff structures for electricity consumers and producers [138–139]. The government, and/or

[6] Infrastructure Development Company Limited, a government-owned non-bank financial institution, for details, see http://idcol.org/home/solar.

the BPDB, purchases electricity from public and private generation companies at a negotiated bulk tariff, and the distribution companies sell electricity to the end customers at an inclining block retail tariff. The retail tariffs are charged based on the electricity consumption and are cross-subsidized (for details, see Supplement B). The agricultural farms, as well as low-income families who consume lower amounts of electricity, pay reduced tariffs [125], while the heavy electricity user groups, including high-income residents and other commercial establishments, pay tariffs exceeding the average supply costs [138].

The size of the middle-income population increased substantially in both rural and urban areas during 2000–2014; it is predicted that the middle class will represent 25–33% of the country population in the 2030s [140]. The number of grid-connected households doubled from 10.8 million in 2009, to 25.9 million in 2017 [141]. Hence, it can be assumed that improved income status and growing demand have induced a recent surge in residential electricity consumption and currently this accounts for the largest share (> 50%) in national electricity consumption [131].

Apart from that, the bulk tariff structure fails to recover the generation costs due to increasing volumes generated by IPPs and rental power plants [138,142]. The generation costs from these private sources are almost 100%-200% higher compared to the BPDB's own generation cost during 2014–2016 (Supplement B). The rental power agreements also include subsidies in the form of lower fuel prices, and a guaranteed monthly rental payment for the producers, irrespective of the amount of electricity generation [143]. This 'short-sighted and ad-hoc' policy strategy has thus resulted in increasing petroleum imports as well as larger subsidies for imported oil products (about US$ 251 million in 2014) [124,144]. The import burden, however, has been passed on to the consumers in the form of increasing retail tariffs. Hence, these lock-ins in fossil fuel subsidies tend to undermine the allocation of investment which would be necessary for renewable energy projects or electricity infrastructure development projects [145]. Recently, the government increased the price of local gas supplied to the power plants. It also reduced the average subsidy rate to 13%[7] in 2016. In addition, increasing utility solar capacity in the next decade might require another series of tariff adjustments, since its generation cost is expected to be higher than that of IPPs or rental power plants.

4.1.4. Information disclosure

The presence of weak institutional frameworks and limited disclosure mechanisms make the provision of adequate energy-related information on Bangladesh a relatively challenging issue. The government agencies and related reporting institutions disclose energy statistics in the official publications, including planning documents, national statistics, annual reports or press releases. However, the reported figures often differ significantly among the reporting authorities. For example, wind-based installation targets by 2019 cited in [146] are 0.07GW, and 0.55GW in [131]. In addition, there is hardly any data regarding electricity generation from commercial biogas plants, even though over 400 plants are currently operating in the country. Also, the widely used international institutional databases, e.g., world energy outlook, BP statistical review etc., publish relatively little on Bangladesh's energy sector. So far, Bangladesh has not signed the transnational standard disclosure for extractive industries [147]. Such a non-transparent regulatory process and asymmetric reporting might play a role in leading to a 'resource curse' for the country.

In terms of information access, the democratic accountability seems to be limited to a 'notice and comment' provision [17]. The citizens are often asked to provide feedback on the proposed regulations and policies at rather late stages of a top-down decision making process. However, the web-circulated notifications are mainly meant to be accessed by particular citizen groups, including civil society groups, energy research institutes, and industry experts. The general consumers tend to become aware of such disclosures only when these are announced in the mass media. Thus, wider 'citizen or public empowerment' in monitoring and amending government's rulemaking [17,91] is limited in Bangladesh. Furthermore, knowledge on renewable energy is largely limited to the population in rural areas [148]. While rural households have better technical know-how concerning solar panels, their knowledge regarding other renewable sources available locally tends to be limited. Also, local participation in the medium-to-large energy projects is non-representative and often the prescribed rules, e.g., environmental impact assessments, are violated in project land acquisitions [149]. In most of the cases, citizen involvement is assessed based on the number of participants in local meetings and the distribution of brochures, rather than on constructive citizen involvement in project-related issues. Thus, stakeholder participation seems to be a 'window-dressing ritual' as suggested in [150], and meaningful and representative engagement has yet to be implemented in Bangladesh.

4.2. National political regime

4.2.1. Political commitment and legitimacy

To combat energy poverty and enhance nationwide electrification, the government initiated the '100% village electrification program' in 2016. Prioritizing the needs of rural poor over urban elites, the government has already electrified 92 out of 460 Upazilas[8] (sub-districts) in full-scale through on-grid connections and off-grid solar home systems. As a result, per capita grid-connected electricity consumption almost doubled in 2017, compared to 2008 levels (158 kWh).

The current political discourse on long-term energy policies seems to point to a preference for coal as the major generation fuel [149], in the context of increasing electricity demand and macroeconomic development targets [127,131]. Renewable sources are, to some extent, less preferred due to high capital expenditures, limited geographical potential, land scarcity and agricultural land use regulations [127]. So far, the government has approved 19 import-based coal power projects (~16GW) which are expected to start commercial operations by 2030 [131]. In fact, the implementation of energy generation policy is sensitive to domestic political leverage [97,136]. For example, general unwillingness, and fragmented opinions among policy makers, on developing a comprehensive and consistent coal policy is delaying local coal extraction in Bangladesh. Moreover, the highly debated Phulbari coal project has been cancelled as a result of large public resistance by locals [151–152] who are, in general, economically less powerful but quite large in terms of votes in upcoming elections [33].

4.2.2. Political stability

The democratic political establishment in Bangladesh is dominated by two major political parties who tend to inherit political power. In terms of polity, Bangladesh is classified as an 'anocracy' with a moderately fragile political system [153]. In 2015, a three month period of political violence was observed due to issues related to elections, with negative effects on the financial system and the economy as a whole [149]. In such an uncertain and weak political environment [154–155], a commitment lock-in might make the execution of existing energy and climate policy reforms expensive or sub-optimal in the long-run. For example, Bangladesh has already experienced major shifts in policy preferences in terms of power generation sources (local coal vs. rental agreements) with periodic changes in the agent rulemakings between 2005, 2009 and 2014. Moreover, policy choices were also influenced by an interim 'caretaker' government (2006–2008) that stressed climate change issues as a top policy agenda and formulated major climate

[7] IEA fossil-fuel subsidies database 2017, see https://www.iea.org/statistics/resources/energysubsidies/ (accessed 17 December, 2017).

[8] 100% Electrification activities in 2017, Bangladesh Rural Electricity Board (BREB); see http://www.reb.gov.bd/ (accessed 27 December 2017).

policy documents [156]. Such policy discontinuation or the lack of a 'tying-hands approach' in political maneuvering might upset investment climate [89,101,157] and often results in a 'blaming culture' in the political discourse.

4.2.3. Bureaucratic procedure

The electric utility sector in Bangladesh tends to be politically corrupt, but also grounded on a bureaucratic corporate culture and a complex administrative setting. For example, it took almost six years until new generation companies could start commercial operations as profit centers, even though the corporatization of such companies had already been enacted [123]. Besides, the enforcement of independent regulator operation was delayed for five years after the approval of the relevant legislation, mainly due to legal and administrative bottlenecks [121]. Apart from that, Bangladesh is ranked as the lowest performer in terms of the 'getting electricity' parameter in the 2017 assessment. This is largely due to its long electricity connection lead times (429 days) and its increasing bureaucracy (9 mandatory procedures) [158]. Although the connection time lag slightly improved (404 days) in the 2018 assessment [159], a well-functioning administrative apparatus with a simplified procedural structure is crucial in implementing political commitments and objectives [31].

4.2.4. Corruption

Over the years, Bangladesh has been consistently reported as being a poor performer in terms of corruption-related parameters [155]. This tends to affect supply security in a highly centralized electricity system. In the early 2000s, the electricity sector was burdened with a poor collection-to-bill ratio, mainly because of the prevalent petty corruption [105]. For example, the urban consumers used to pay bribes to the meter readers to reduce monthly electricity bills by tampering meters [126]. However, the situation has since improved (collection-to-bill ratio: 96% in 2017) due to commencement of the electronic billing system and continuous monitoring. Different types of firm-level malpractices also exist, although these are rarely documented. For example, the local manufacturing firms seek to bribe power officials in securing uninterrupted and reliable electricity connections (fewer voltage fluctuations). There also is evidence[9] that multinational oil and gas companies offer bribes to government representatives to obtain contracts or to pay lower levels of compensation to communities affected by energy projects. The existence of such corruption undermines sectoral efficiency in the long-run and results in unnecessary costs, usually borne by low-income consumers [105].

4.3. Quality of infrastructure

4.3.1. Power plants

In the early 2000s, the electricity sector stagnated in terms of installation capacity (~4GW) and number of operating power plants (27). Poor thermal efficiency and continuous supply-demand mismatch during peak hours [139] also resulted in frequent load shedding (as high as 1.4GW in 2010). During 2009–2017, 84 new power plants, with a cumulative installed capacity of 8GW, were set up with the advent of privately financed power generation sources. The overall efficiency improved to 35% and maximum load shedding plummeted to 0.25GW in 2017. This can be compared to 2011 levels, of 31% and 1.3GW, respectively. However the maximum peak generation capacity is still inadequate to match maximum peak demand; for example, the supply-demand gap exceeded 2.5GW during 2015–2017 [160]. Moreover, periodic maintenance of power generators, fluctuations in frequency control, manual dispatch protocols, lack of (spinning) reserves, and inefficient rationing of gas supplies remain considerable issues despite adequate generation capacity [127,161]. In addition, the fossil fuel-based power plants need to operate during peak demand hours, especially in the evening. Considering current and planned power plants, the electricity sector is expected to substantially increase the national carbon emission inventory in the long-run [139].

4.3.2. Grids

To aid nationwide electrification, the government has decided to extend distribution lines up to 478 thousand kilometers, excluding non-reachable and low density areas [127,131]. Policymakers have also argued that the integration of ~5–10% intermittent renewables into the national electricity grid might not require further upgrading or development of existing grid networks [127]. However, inadequate grid-connected facilities, lack of grid-parity access, and non-compliance with grid regulations seem to hinder large-scale implementation of renewables. Similar issues have recently been found in other countries as well [101].

In the late 1990s, the electricity system performed poorly, and distribution losses exceeded 30% due to extensive illegal grid connections [20,121]. Installations of smart meters are currently being implemented to counteract electricity theft. Consequently, in 2017, distribution losses reached their lowest level ever (10%) [131]. The government has also set a yearly target for smart meter installations for the six distribution companies to further reduce the non-technical losses; these installations, however, are progressing slowly. This slow growth can be attributed to consumer resistance to using pre-paid smart metering instead of the conventional post-paid meter billings, which allow customers a certain degree of flexibility in paying their electricity bills.

4.3.3. Resource logistics

Insufficient and weak supply infrastructure for energy resources is one of the major constraints in the Bangladeshi electricity sector [162–163]. A 24,037 km[10] gas pipeline network distributes domestic natural gas to the gas power plants, which currently account for the largest share in national gas consumption. Facing depleting local gas reserves, Bangladesh is moving towards liquefied natural gas (LNG) imports, and the import infrastructure is currently being constructed. The first phase of a floating storage re-gasification unit is expected to be commissioned in 2019, and the daily supply capacity will be 500 million standard cubic feet [127]. The overall quality of existing port facilities is poor [163] and there is an increasing reliance on imported coal for upcoming coal power plants. As a short-term strategy, the coal power plants will be individually responsible for importing and storing coal. In addition, a central coal transshipment terminal will be included in the deep sea port of Matarbari, near the Bay of Bengal, and is currently under construction. The first unit is expected to commence operation with an annual storage capacity of 10.4 million tons by 2025 [127]. The only coal power plant in Bangladesh so far does not require road transport, as it is operating in direct proximity of the Barapukuria coal mine.

4.4. International landscape

4.4.1. Investment and technological development

An undeveloped national financial system and the poor financial capacity of public utilities increase the dependence on transnational investment flow to Bangladesh's electricity sector. However, the investment growth so far remains as low as in other lower middle-income countries [139]. To achieve future generation targets and to develop

[9] For details, see http://www.cbc.ca/news/canada/calgary/calgary-s-niko-resources-to-pay-9-5m-bribery-fine-1.987297. Also, see http://www.ey.com/Publication/vwLUAssets/EY_-_Mitigating_fraud_bribery_and_corruption_risks_in_bangladesh/$FILE/EY-mitigating-fraud-bribery-and-corruption-risks-in-bangladesh.pdf (accessed 17 December 2017).

[10] For details, see https://petrobangla.org.bd/?params=en/gasproductiondistributionpipeline/pipeline/ (accessed 17 December 2017).

Table 2
Foreign investments in the proposed coal-based power plants in Bangladesh.
Source: NRDC Consolidated Coal and Renewable Energy Database 2017.

Project	Donor country	Capacity (MW)	Technology	Investment[1]	Project type
Payra Coal Power Station (Phase 1)	China	1320	Ultra-supercritical	$1900	JVC[2]
Alam Banskhali Chittagong Power Plant	China	1320	Supercritical	$1739	Private[3]
Rampal Maitree Coal Fired Power Plant	India	1320	Ultra-supercritical	$1600	JVC
Mawa Coal Power Plant	South Korea	680	Ultra-supercritical	–[4]	Private
Maheshkhali Coal Plant	China	1320	Ultra-supercritical	–	Public[5]
Matarbari Coal Fired Power Generation Hub	Japan	1200	Ultra-supercritical	$4510	Private
Gazaria Coal Plant	China	350	Ultra-supercritical	–	Public
Payra Coal Power Station (Phase 2)	China	1320	Ultra-supercritical	–	JVC
Burirdanga Coal Plant[6]	United States	660	Supercritical	–	Private
Barapukuria Ashuganj Power Station[6]	China	1320	Subcritical	–	Private
Maheshkhali Power Station (Huadian)[6]	China	1320	–	–	Private

[1] In million USD.
[2] Joint venture with public generation company.
[3] Private generation company (IPPs).
[4] No information available.
[5] Public generation company.
[6] Postponed projects.

the requisite energy infrastructure, the government has planned to source roughly US$42 billion in the form of different investment vehicles, e.g., joint-ventures, export credit financing, etc. [131]. In recent times, a sustained GDP growth rate has opened up immense investment opportunities through bilateral joint-venture agreements and co-operative commitments of the development donors [164]. Between 2013 and 2016, Bangladesh managed to attract more international public finance in fossil fuel projects (mainly coal) relative to renewable projects [165]. In 2017,[11] about 78% of total foreign direct investment (US$340 million) in the power sector was sourced from Asian countries. India, China, Japan and Singapore made large contributions to fossil fuel-based new capacity installations in terms of investments and technical capacity development. As a part of Belt and Road Initiative (BRI), China is providing financial assistance for coal mining and coal power plants across Asia Pacific regions through local Chinese banks, the Asian Infrastructure Investment Bank (AIIB), and the New Development Bank (NDB) [166]. China has already committed to invest in seven coal power projects of (in total) ~8.3GW installed capacity in Bangladesh (Table 2).

Nonetheless, most of these funding items include government guarantees as a form of equity and a relatively high portion of external debt financing. Thus, excessive foreign debt and its impact on the national budget is a crucial issue for Bangladesh [149]. In terms of capacity investment, Bangladesh has been importing electricity from India since 2013 through regional, interconnected transmission grids based on a 25-year government-to-government power trading agreement [23]. As of 2017, power imports accounted for 5% (i.e. 0.60GW) of total generation capacity and are expected to increase to 0.90GW by 2020 [160]. In terms of technological development, the development partners transfer technology (equipment, machinery) and provide engineering, procurement and construction services (technology-specific knowledge, skills and technical know-how) to the electric utilities. However, this imitation mechanism is likely to increase Bangladesh's long-term, external dependency, since the associated intellectual property rights often limit access to the required tacit knowledge concerning the imported technologies [113,167].

Bangladesh has also received development assistance from multilateral donor agencies, e.g., the Asian Development Bank (ADB) and the World Bank Group, in terms of generation investments, upgrading and expansion of transmission and distribution networks, and cross-border power trading [162,168]. Over the years, ADB remains the most 'consistent and reliable' donor for Bangladesh [122] with its investment cooperation in different energy projects, including market reforms, Bangladesh-India interconnected electric grids, LNG terminals, etc. The World Bank Group on the other hand provides financing facilities mostly for the upgrading of transmission networks, rehabilitation of old power plants, and diffusion of solar home systems and mini-grid projects [169]. However, such a small number of development agencies clearly represents a 'monopolistic donor structure' [170], and in the past, monopolistic donor structures often failed to inject the substantial investments necessary in scaling up electricity generation.

4.4.2. Energy diplomacy and interventions

Bangladesh is considered to be an emerging market for the rising energy donors, mainly China and India, due to the growing electricity demand, imminent reliance on fossil fuel imports and its strategically interesting geographical location as a regional trade hub [149,162]. Bangladesh is endowed with limited reserves[12] of gas (7.3 trillion cubic feet) and coal (3.3 billion tons). The implementation of the announced large-scale coal power strategy, however, will require 144 million tons of coal in the next decades, of which almost 80% will be imported from India, Australia and Indonesia [127]. Although there is no sign of local coal development at present, the policymakers have recently focused on coal mining issues in order to establish a more secure energy flow. The enhancement of local coal power might be feasible with improved mining technologies and a proper assessment of newly discovered coal deposits [171]. In this situation, the regional powers of China and India seem to be in the process of extending their diplomatic influence on resource exploitation, as evidenced in other developing countries, e.g., [13].

China has been involved in underground coal mining activities at the Barapukuria coal field since 2005, and the expansion of current operations is under way using surface mining technology [127,131]. In contrast, India's participation in the Bangladesh electricity sector only started in 2013 in the form of regional grid-connected power trading. The geopolitical dominance of India is also evidenced in cross-border energy dealings [23], e.g., hydropower imports from Nepal and gas imports via the TAPI (Turkmenistan-Afghanistan-Pakistan-India) gas pipeline network [127,172]. India's ambitious move towards coal-based power generation strategies and foreign reserve acquisitions

[11] Bangladesh Bank Statistics for Gross FDI inflows in power sector during the fiscal year 2017, available at https://www.bb.org.bd/econdata/fdi.pdf (accessed 17 December 2017).

[12] Natural gas reserves (also, reserve-production ratio: 7.5 years) as per BP Statistical Review of World Energy June 2017 and coal reserves as stated in Power System Master plan 2016 [127] of which 538 million tons are mineable.

[173] may be seen as an opportunity for Bangladesh to expand its coal regime. In addition, the existing investment monopolies (i.e. donor groups) tend to impose stringent aid conditions on Bangladesh, as was the case with forced market reforms in the 1990s [22]. Also, the open-pit coal project in Phulbari, supported by British and US investments, exerted pressure on Bangladesh's government to force approval of the project, irrespective of public resistance [152,174]. Furthermore, Bangladesh is largely dependent on the donor agencies, e.g., the Japan International Corporation Agency (JICA), for policy advice on energy-related issues. Such donor-driven policies clearly result in a nexus of energy infrastructure development and national governance [88], which makes it difficult to balance the interests of the local population, national policy makers and international investors.

5. Conclusions

Bangladesh's electricity system is growing as a result of industrialization and the increasing electricity demand from its large population. Challenges related to this growth include dwindling local gas reserves, a barely diversified generation mix, inadequate distribution networks, and supply-demand mismatches.

In the current single buyer market setting, notable improvements have been achieved in generation capacity although competition among electric utilities still remains limited. Policy makers formulate the necessary generation policies and related energy legislation in tandem; subsidies are granted for financially weak users at the expense of tariff structures which do not reflect electricity generation costs. The national political landscape favors and legitimates the extension of fossil-fuels to provide reliable and cost-effective electrification. The national grid capacity is also gradually improving due to extended transmission and distribution lines in order to achieve 100% electrification by 2021; system losses are declining overall, and the quality of electricity supply is improving.

On the other hand, the inconsistent political environment, complex bureaucratic practices and widespread corruption complicate policy formulation processes, and policy execution often lacks consistency. The disclosure of energy-related information is limited and lacks distributive governance with only marginal stakeholder participation in decision-making processes. Bangladesh's electricity sector is largely dependent on foreign investments for energy infrastructure development and technology transfers. External interventions and cross-border diplomatic energy relations appear to exert some influence on national energy security policies. This becomes particularly obvious when, e.g., foreign investments facilitate the massive extension of coal-based power generation [175]. This political position naturally raises controversies, given that Bangladesh is immensely vulnerable to climate change impacts (rising temperature and sea level, salinity intrusion, droughts, etc.) [176].

A critical evaluation of Bangladesh's energy governance landscape thus points to an unsustainable transition in the electricity system. The desire for energy service security, in particular, for universal and affordable electrification, serves to override the momentum towards a sustainable low-carbon transition. The current governance storyline is based on a 'central co-ordination' pathway [177] in which the government dominates existing market settings and policy domains in order to ensure the requisite electricity provision. In the context of resource-poor settings, energy politics in Bangladesh largely hinges on the transnational cooperation and geopolitical influence that currently reproduce the viability of the existing fossil fuel-based electricity system.

Infrastructure investment from new financial institutions, mainly led by China's BRI initiatives and current disagreement on climate finance mechanisms [166,178], have created a window of opportunity for coal. Investment in more efficient coal-based power plants is often even considered as climate finance [178]. By such means, investors can shift environmental externalities to developing countries with weak institutional capacity while still profiting from coal projects, something which is becoming increasingly difficult in domestic markets. Such 'carbon leakage' tendencies, however, undermine the positive effects of phasing out coal in developed countries, and impair global climate mitigation efforts. Hence, the creative destruction of the fossil fuel regime [179] becomes somehow locked-in within the international political economy of energy. At the same time, efforts by multilateral donors to promote renewables are rather scarce in Bangladesh, and respective national funding schemes lack proper execution mechanisms.

A key issue for energy governance is thus to provide an action space for addressing energy-related challenges, and to facilitate coordinated measures. These need to consider prevailing institutional properties and inclusion of actor groups at different levels in order to eventually ensure energy service security. Secure provision of electricity can only be achieved by properly addressing the interlinkages between different actor regimes and institutional endowments. A context-specific energy governance framework is definitely helpful to capture such multi-faceted interactions. The quantification of single governance aspects often overlooks complex trade-offs; in contrast, the energy governance framework proposed and applied in the present study operates on an interpretative level and provides a qualitative guideline in order to empirically investigate the critical phenomena associated with electricity security. This framework can thus be used to provide meaningful qualitative insights to both the academic and policy community.

At the end of the day, the integration of energy governance and energy security perspectives is crucial to understanding and addressing the challenges of a just energy transition in the face of the standard energy trilemma, i.e. the balancing of energy security, energy equity and environmental sustainability. Unless this question is properly resolved, proponents of fossil fuel extension in developing countries may easily hide behind ethical and moral arguments of energy justice, and sideline the major environmental and climate-relevant implications.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.apenergy.2018.04.081.

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